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Promising outcome of pectoralis major muscle reconstruction surgery a few months after injury - a review

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ABSTRACT

Introduction: Reports of pectoralis major muscle (PM) ruptures are becoming more common, and they mainly affect young, active male patients. The most prevalent cause of the injury is an eccentric contracture of the muscle, which happens during weight training when doing the bench press maneuver. *The aim:* The purpose of this article is to present pectoralis major injury as a curable disease even when the time frame for direct repair has been missed or reattachment of the tendon to the bone is not possible. *Case report:* The described case is a 26-year-old patient who arrived at the emergency room with severe pain in his left shoulder after an injury while bench pressing a barbell at the gym. Upon physical examination, the patient reports pain in the shoulder girdle when raising his left arm. *Results:* All young patients with PM tears should have access to surgical therapy, regardless of activity level. At the same time, conservative management should be reserved for senior patients with low activity levels and those who are medically unfit. *Conclusions:* PM ruptures are rare injuries that frequently affect young men in their 20s to 40s. Following a complex exercise, patients typically come with shoulder pain and weakness, and an MRI can be used to diagnose.

Keywords: Pectoralis major muscle, pectoralis major injury, trauma of pectoralis major

1. INTRODUCTION

The pectoralis major muscle is a flat and wide muscle belonging to the superficial muscles of the chest. It is the largest and most superficially located muscle in this area. Spreading between the clavicle, the sternocostal region, and the humerus, it plays a vital motor function (Lee et al., 2024). The following parts can be

distinguished in the structure of the pectoralis major muscle (Chiavaras et al., 2015):
Superior - clavicular, with attachment to the medial part of the clavicle
Median - sternocostal, with attachment to the anterior surface of the sternum and cartilages of ribs 1-7
Inferior - abdominal, with attachment to the anterior surface of the rectus abdominis muscle sheath.

In the above areas, the pectoralis major muscle has its beginning, it's initial attachment is located there. From this point, the muscle fibers finally end in a tendon on the crest of the greater tubercle of the humerus, which is the terminal attachment of the pectoralis major muscle (Chiavaras et al., 2015). The pectoralis major muscle has been innervated by the medial and lateral pectoral nerves (Brown et al., 2021). The muscle has been supplied by the thoracic branches of the thoracoacromial artery, branches of the intercostal arteries, and the lateral thoracic artery. Function of the pectoralis major muscle (Lee et al., 2024; Saeed et al., 2024):
Adduction of the arm (adduction) - pulls the arm toward the torso.
Internal rotation of the arm - rotates the arm inward).
Flexion of the arm - mainly the clavicular part raises the arm forward (to the horizontal).
Lowering the raised arm - the muscle helps lower the arm after it has been raised.
Pulling the scapula to the rib cage – stabilizes the scapula through tension.
Auxiliary respiratory function – during deep inspiration (especially with a fixed shoulder girdle), the muscle acts as an auxiliary inspiratory muscle, lifting the ribs and increasing the volume of the rib cage.

The pectoralis major is the strongest muscle that adducts and depresses the arm. Injuries to the pectoralis major are not common. Injuries occur more often in men, mainly during strength training, as a result of which the muscle attachment to the humerus is torn off (Kowalczuk and Elmaraghy, 2022; Chomič et al., 2022; Pedrazzini et al., 2017; Butt et al., 2015; Magone et al., 2021; Saeed et al., 2024; Qylafi and Alkhalfan, 2022). In our work we will present the case of a young man who came to the emergency room due to severe pain in the left shoulder area after an injury at the gym while bench pressing a barbell.

2. METHODOLOGY

This review was conducted by searching for current papers on PubMed and Google Scholar using the search phrases (pectoralis major muscle) AND (pectoralis major injury) AND (trauma of pectoralis major). After eliminating duplicates, we appraised all publications using the titles and abstracts. Studies that have made a significant contribution to science were included in the review (Table 1). Following an exact revision of complete manuscripts, 21 articles met the inclusion criteria. After reviewing 21 articles, we checked whether the procedure and treatment implemented in the patient's case were correct.

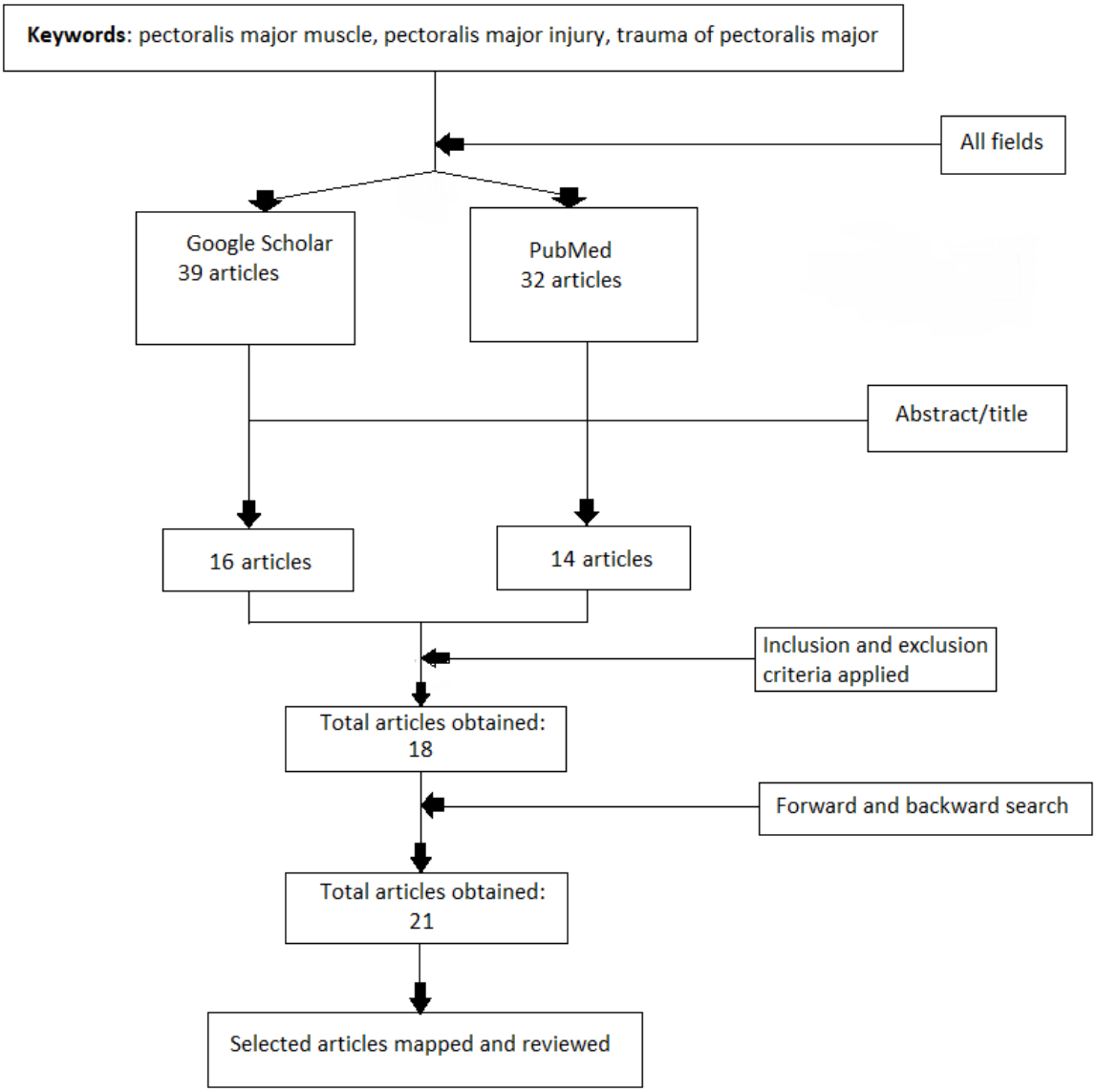

Table 1 Flow chart

3. CASE DESCRIPTION

A 26-year-old man presented to the Emergency Room at the Infant Jesus Hospital in Warsaw with severe pain in the left shoulder region after an injury at the gym while bench-pressing a barbell. The patient reports shoulder girdle pain while lifting the left arm. The patient reports that the pain radiates to the area of the long head of the biceps brachii muscle and to the area of the pectoralis muscle attachment. The patient rates the pain at 7-8 points out of 10 on the NRS scale. Range of motion in the left shoulder joint is pain-limited. At the periphery of the limb, mobility, sensation, and circulation are preserved. Other areas of the limb are not painful. Key sign is negative. Popey's sign is negative. The distal attachment of the biceps muscle of the left arm is palpable on physical examination.

An injury to the proximal attachment of the long head of the left biceps muscle or the attachment of the left pectoralis major muscle was suspected. The doctor applied a triangular sling to relieve pressure on the affected limb. The patient was discharged from the ER with recommendations for a sparing lifestyle. The doctor prescribed antiedematous medication and etofenamate ointment on the skin for anti-inflammatory and analgesic effects. The doctor also prescribed an opioid (tramadol) to relieve moderate to moderately severe pain. The patient received a referral for an outpatient ultrasound examination at the outpatient clinic and to report the result to the trauma and orthopaedic surgery clinic. The doctor performed an ultrasound examination of the left shoulder joint.

The ultrasound shows a pool of fluid in the area of the lower edge of the left pectoral muscle (Figure 1). The orthopedic surgeon performed a puncture of the haematoma under the ultrasound guidance and collected 12 ml of fluid from the area of the attachment of the injured muscle. The doctor made the decision to use platelet-rich plasma. The patient was given two doses of PRP and PRF under ultrasound guidance. Rehabilitation exercises in a sling in a pain-free range and a follow-up after two weeks were recommended. The patient came to the clinic after two weeks for a scheduled follow-up visit and reported less pain and increased range of motion in the affected shoulder joint. A second ultrasound examination of the shoulder joint shows a slightly smaller fluid reservoir.

The doctor performed an LP and decompressed the remaining fluid under ultrasound guidance. The patient received another dose of PRP and PRF. The next follow-up appointment was in four weeks. After another follow-up, it was determined that the patient did not require further doses of PRP and PRF. The doctor recommended stretching exercises before returning to full sporting activity. The physiotherapist guided the patient's rehabilitation. The patient also performed minor resistance exercises and support exercises. The physiotherapist also suggested rehabilitation treatments involving radiofrequency technology to accelerate the repair of damaged tissues. After months of rehabilitation the patient regained a full and symmetrical range of motion. Daily activities did not cause him any pain or difficulty.

However, any sporting activity was still virtually impossible. The patient visited a private orthopedic clinic approximately eight months after his injury due to his desire to return to physical activity. The doctors recommended that the patient have an MRI scan. On MRI, the radiologist found complete damage to the tendon of the pectoralis major muscle with retraction and remodeling of the muscle attachment stump (Figure 2). The radiologist found the stump approximately 60mm from the attachment field on the crest of the greater humeral cusp. The patient complains of pain in the pectoralis muscle while running and while lowering into a hang from a pull-up bar. The patient cannot perform even one push-up (before the injury, he could perform about thirty push-ups). The doctors have suggested surgery for the patient.

Because of the long time after injury and the distance from the remaining tendon to the bone, the doctor advised the possibility of reconstruction surgery if direct repair fails. The physicians selected the Achilles Tendon allograft as the preferred method for the surgical procedure. The patient came to the clinic for the surgery. The operation took place under general anesthesia. The doctor made an approximately eight-centimeter incision on the anterior axillary fold. The orthopedic surgeons released the adhesions of the pectoralis muscle and mobilised the retracted muscle as close to the original site as possible. An attempt was made at primary tendon repair. After an unsuccessful attempt, the doctor performed a reconstruction using the allograft tendon.

The doctor then prepared the stumps of the distal part of the pectoralis muscle to which the new tendon was attached and made the appropriate incisions of the allograft to fit the patient best. The orthopedic surgeon located the tendon attachment site on the humerus, and fixed the tendon to the humerus using three titanium buttons and four surgical tapes. The surgeons used dissolvable sutures to suture the wound. During hospitalization, the patient was given analgetic, antiedematous medication and antibiotic (Cefazolin). The day after surgery the patient went home in the sling in good condition. The surgeons recommended changing the dressing every two days, wearing a sling consistently and doing elbow exercises at home.

Three weeks after the operation, the tendon's stability would be confirmed during the first scheduled visit, and the patient would then begin the rehabilitation protocol. The patient came to the clinic for a scheduled follow-up twelve weeks after the operation. The doctor performed an ultrasound and found a graft with preserved continuity and correct structure, relatively thick (approximately one centimeter), correctly tensioned on rest examination, and dynamically stable - numerous artifacts from the anastomotic bands on the course of the graft and attachment to the humerus. The doctor also examined the patient and found no swelling around the operated tendon.

On physical examination, the shoulder joint maintained mobility. The patient does not complain of shoulder pain. The doctor allowed the patient to start doing push-ups and pull-ups gradually. Bench press was allowed, but not heavier than 40kg. The patient exercises with a physiotherapist three times a week according to a rehabilitation protocol. The patient showed colossal improvement under the guidance of a physiotherapist compared to his state before the surgery. The patient reports that he experiences no discomfort while running and he can do more push-ups than before surgery. The patient is satisfied with the total outcome of the treatment.

Figure 1 A fluid reservoir near the inferior margin of the left pectoralis muscle.
*The source of the images is the patient's records, obtained with their consent for use in the article.

Figure 2 Damage to the tendon of the pectoralis major muscle.
*The source of the images is the patient's records, obtained with their consent for use in the article.

4. DISCUSSION

Male youth who engage in weightlifting activities are at risk for PM muscle rupture (Alayane et al., 2023). Pectoralis major tendon tear is often heard as a "pop" during eccentric loading workouts (Cordasco et al., 2017). The study found that 2% of patients experienced a PM tear during the high-intensity CrossFit workouts and 50% of patients experienced one during the bench press (Godoy et al., 2018). The lower fibers of the sternocostal head of the pectoralis major muscle are most frequently torn. The tendon of the pectoralis major muscle most commonly tears at its humeral attachment (Chadwick et al., 2023).

Clinically, an athlete may experience pain, bruising, and swelling in the medial upper part of the arm and the chest wall. Other symptoms include functional limitations in adduction and medial rotation (Pochini et al., 2015). Ultrasound is a great tool for the preliminary screening of an injury, it allows us to assess the severity of the pectoralis major tear. However, the gold standard technique is MRI, which can help with diagnosis, surgery planning, and providing prognostic and outcome information. In addition, MRI allows for excluding other pathologies, such as muscle strains and contusions (Lee et al., 2017).

We identify two management approaches for the patient: Conservative and surgical. Conservative treatment includes pain management, lifestyle modifications, and physical therapy which may involve ultrasound, electrotherapy, passive range-of-motion exercises, stretching, and mild resistance exercises. These interventions finally permit resistance program training and sports participation (Kowalczuk and Elmaraghy, 2022; Bodendorfer et al., 2021). Various types of grafts may be used in surgical treatment including gracilis-semitendinosus autograft, semitendinosus allograft, fascia lata allograft, bone-patellar tendon autograft, iliotibial band autograft and Achilles tendon allograft (Giordano et al., 2023).

In our patient, an allogeneic graft of the Achilles tendon was selected. Its dimensions are comparable to those of the native pectoralis major, which is approximately 5 to 6 cm long medially and 4 to 5 cm wide proximally and distally. The ability to cut the allograft to mimic the unique shape of the pectoralis major tendon insertion is also a benefit (Rivera et al., 2023). Though some may be simpler or more pleasant for a specific surgeon, none of the methods discussed in the literature have shown biomechanical superiority. The research suggests that the surgical procedure for treating tears in the pectoralis major muscle should be determined by the surgeon's skill level and personal preferences (Gupton et al., 2019).

We should remember that a crucial element of effective therapy is postoperative rehabilitation. It begins under the supervision of a trained physiotherapist and focuses on early passive and active-assisted range of motion. In the first 2 weeks, flexion up to 90°, abduction up to 30°– 45°, and external rotation up to 20° are allowed. Then, the range of motion is gradually increased, depending on tolerance. Resistance training begins 6 to 12 weeks after surgery (Prabhu et al., 2017). Contact sports activities and heavy lifting should be avoided for at least six months (Giordano et al., 2023).

5. CONCLUSIONS

Rupture of the PM is an injury that is becoming more common among bodybuilders as a result of their intense weightlifting regimes, and it is most likely unrelated to limb dominance. Treatment is determined by the location, thickness, and chronicity of the rupture. Regardless of the severity of the damage, tendon fixation using cortical endobuttons produces excellent clinical outcomes and increases postoperative patient satisfaction. Patients who have irreversible damage, incomplete tears, advanced age, or medical comorbidities should receive nonoperative treatment. It has been demonstrated that patients receiving non-operative treatment lose strength but regain full range of motion.

Compared to patients who had surgery between 6 and 8 weeks, those who had surgery before 6 weeks reported superior results. The chance of repair with autografts or allografts is increased if the rupture is persistent (>8 weeks). Although satisfactory outcomes have also been observed with delayed repair of entire injuries, early anatomic repair for complete ruptures can yield excellent results. Early identification and, where necessary, anatomic surgical correction are crucial to improving patient outcomes following pectoralis major rupture.

Author's contribution

Dominik Chrzanowski: Methodology, review and editing, investigation
Cezary Bochyński: Conceptualization, investigation, visualization, supervision
Klaudia Włodarczyk: Conceptualization, methodology, resources, supervision
Dominika Kropidłowska: Review and editing, formal analis, visualization
Patryk Góralski: Resources, writing- rough preparation, data curation
Patrycja Pysz: Review, Visualization, data curation, investigation
Kinga Świtała: Resources, writing- rough preparation, formal analyis
Project administration: Dominik Chrzanowski

Informed consent

Written & Oral informed consent was obtained from individual participants included in the study.

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Ethical approval

Not applicable.

Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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